EFFICACY OF THREE DIFFERENT ROTARY RETREATMENT SYSTEMS TO REMOVE LATERALLY AND VERTICALLY COMPACTED GUTTAPERCHA - A CONE BEAM COMPUTED TOMOGRAPHIC EVALUATION

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In partial fulfillment for the Degree of

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CERTIFICATE BY THE GUIDE

This is to certify that this dissertation entitled **"Efficacy of three different Rotary Retreatment systems to remove Laterally and Vertically compacted gutta-percha - A Cone beam Computed tomographic evaluation"** *is a bonafide research work done by* **Dr. Rinsa Raju** *under my guidance during her postgraduate study period between* ***2016- 2019.***

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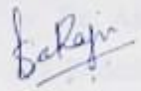

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LIST OF ABBREVIATIONS USED

(IN ALPHABETICAL ORDER)

ABBREVIATION	WORD EXPLANATION
ANOVA	Analysis of Variance
ANCOVA	Analysis of Co-Variance
AV	Area of Voids
BIS –GMA	Bis Phenol A Glycidyl Methacrylate
BF	Back Filling
CBCT	Cone Beam Computed Tomography
CT	Computed Tomography
μ-CT	Micro CT
DICOM	Digital Imaging and Communications in Medicine
EDTA	Ethylene Diamino Tetra Acetic acid
FOV	Field of View
GP	GuttaPercha

HClO	Hypochlorous acid
NaOCl	Sodium hypo chlorite
RVG	Radiovisiography
SEM	Scanning Electron Microscope
SPSS	Statistical Package for the Social Sciences
WL	Working Length
VP	Volume Percentage
VV	Void Volume

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INTRODUCTION

The Endodontic treatment success is directly related to many factors which are linked in a cyclic chain so that if one is broken, the probability of treatment failure increases. These factors include accurate diagnosis, proper maintenance of aseptic environment, knowledge of tooth morphology, proper chemo-mechanical preparation and three dimensional filling of the root canal system. Any faults of these steps will lead to Endodontic treatment failure[1].

Root canal anatomy plays a major role in Endodontic success and failure. These root canal systems contain branches that communicate with the periodontal attachment laterally, furcally, and often terminate apically into multiple ways of exit. Any opening from the root canal system to the periodontal ligament space should be thought of as a portal of exit through which potential Endodontic breakdown products may pass[2].In addition to above reasons, emergence of post-treatment diseases because of persistent bacteria in the root canal system is on the increase. This may because of improper cleaning, untreated canals, insufficient filling, overextension of filling materials, complications of instrumentation (ledges, perforations, separated instruments)and coronal leakage[3,4].

According to the Glossary of Endodontics, retreatment is a procedure to remove root canal filling material from the tooth, followed by cleaning, shaping, and obturation of the canals[5].The main goal of retreatment was regaining access to the apical foramen by complete removal of root canal filling material, thus facilitating sufficient cleaning and shaping of complete root canal system and final obturation[6]. If the filling material can be removed completely and the root canal negotiated to the apical foramen allowing

thorough debridement, only then the retreatment can be successfully done. Aim of the root canal retreatment is to substantially reduce or eliminate the microbial load from the root canal.

Many materials are being used for the filling of root canals, of which Gutta-percha (GP) with a variety of sealers is the most common method. Many techniques have been advocated for the removal of gutta-percha in root canal-treated teeth such as hand files, engine driven rotary files, ultrasonic tips, lasers and heat carrying instruments. Removal of gutta-percha using hand files with or without solvents is time consuming especially when the fillings are well condensed[7].

Nickel–titanium (NiTi) rotary instruments has been used successfully in root canal cleaning and shaping. NiTi rotary retreatment systems has been introduced because of their safety, efficiency and speed in removing gutta-percha and the sealer. Different rotary retreatment systems have been designed for gutta-percha removal such as ProTaper Universal retreatment system, R-Endo retreatment, Mtwo, WaveOne retreatment system, D-RaCe retreatment instruments, The Reciproc (REC) system and Flex Master retreatment instruments[7,8].

Researchers have shown that the morphologic feature of root canal system is not a single tubular space within the root structure. The presence of accessory canals, anastomoses lateral canals and fin-shaped extensions give the canal spaces a complex type of configuration[9]. The aim of Endodontic obturation is to give a complete sealing along the full length of the root canal system. But, with the currently available techniques the total obturation of all canal structure is still impossible. The lateral condensation technique is the one of the most regularly used techniques in Endodontics. However, its ability to

replicate the total internal structure of a root canal has been questioned over the years. Problems like voids, spreader tracts, incomplete fusion of the gutta-percha cones, and lack of surface adaptation have been reported. To overcome these problems the another technique called warm vertical condensation was introduced to provide high-density filling and better sealing of all portals of entry between the root canal and the periodontium, which also provides homogeneity and surface adaptation of gutta-percha[10,11].

Treatment planning fora diseased tooth is a complex process. A detailed dental history, clinical evaluation and radiographic examination are necessary to make an accurate diagnosis prior to treatment. Assessment of remaining tooth filling material can be evaluated by various methods, mainly two types-destructive and non-destructive method. Methods such as longitudinal cleavage can be measured with a scoring system, tooth sectioning with stereomicroscope examination, combination of longitudinal and transversal splitting and combination of cleavage and photography in association with radiographic examination. Limitations of these methods are cleavage and splitting may not be accurate because of some residual material is likely to be lost in this process and radiographic images provides only two-dimensional information of a three dimensional tooth structure. By using 3Dtechniques such as CT, Micro-CT and CBCT images provides volume of remaining root canal filling materials. These methods provides detailed visualisation of morphological features without destruction of the tooth structure and creates a three dimensional image and reproducible data that can be used for the comparison of root canals before and after filling removal[12,13].

The recent introduction of three-dimensional imaging into Endodontics had a significant impact on treatment planning. Limited field of view (FOV) cone beam computed tomography (CBCT) is the new imaging modality of choice for teeth with complex post-treatment disease. The Joint Statementof American Association of Endodontists and the American Academy of Oral and Maxillofacial Radiology states that limited type of FOV CBCT should be the imaging modality of choice when evaluating the non-healing previous Endodontic treatment and for nonsurgical retreatment to assess treatment complications or deficiencies that may have occurred during the previous Endodontic treatment. Small FOV type CBCT enables the Endodontist to consider selective root retreatment addressing only the particular portion of roots with radiographic evidence of disease.This is because of its increased sensitivity in detecting roots with a periapical low density area when compared to 2-D type radiographs[14,15].

Removal of complete filling material ensures the success of non-surgical endodontic retreatment. However, the currently available techniques are not capable of completely removing the root canal filling material. Studies show that manual instrumentation with Gates Glidden was the least effective method of removal, because of the friction created by stainless steel files against root canal walls. Moreover, mechanical techniques take more time and is less demanding for both the patient and the operator. Whereas numerous studies have shown that, the rotary retreatment file systems was the most effective method of removing filling material and various studies also reported their efficacy, cleaning abilityand safety of removal. For assessing remaining filling material radiographic images provides 2D images and they cannot distinguish sealer from gutta-percha and images may be subjected to magnification and distortion. Whereas three-dimensional images provides reconstruction of slices produces images that detailing the

anatomy of entire root canal system before and after instrumentation. In this study, CBCT was used to assess the volume of filling material that remained inside the root canals after removal. This method facilitated distortion-free, highly detailed images. In using the CBCT Imaging software for volumetric analysis the advantage was that it was possible to precisely outline the remnants of filling material and to calculate its volume in cubic millimetres precisely[16,17].

AIM

The aim of this study is to compare and evaluate the effectiveness of three different gutta-percha removing techniques in lateral and vertical compacted obturation technique using cone beam computed tomography.

OBJECTIVES

1) To Compare and evaluate the efficacy of Protaper R ,M -two R, and D-Race files systems.
2) To Study the effects of retreatment files systems on lateral and warm vertical obturation techniques.
3) The Volumetric calculation of residualobturation material in root canal spaceusing CBCT.

NULL HYPOTHESIS

The null hypothesis states that

1) There was no difference in the efficacy of three different retreatment file systems used in this study.
2) There was no difference in the effects of retreatment file systems on lateral and warm vertical obturation techniques used in this study.

REVIEW OF LITERATURE

1) **JorgensenB** *et al* in **2017**[18]did a study on the efficacy of "Waveone reciprocating system versus the Protaper Retreatment System in endodontic retreatment of two different obturating techniques. The samples were obturated with warm vertical method or GuttaCore. The results showed that the WaveOne Primary files undergoes more separations and are unable to remove filling material as efficiently as the ProTaper Universal Retreatment files. Also they noted that, the root canals obturated with GuttaCore were retreated more efficiently and with fewer file separations than the root canals obturated by continuous wave method.

2) **Preetam** *et al* in **2016** [19] They compared the efficiency of manual and rotary instrumentation techniques for retreatment. The results showed that the effective removal of root canal filling material might not be achieved with the use of both the rotary and hand file systems. But the rotary instruments were more effective in removing the gutta-percha. There was no significant difference observed between the efficiencies of two rotary systems used. The use of the ProTaper Retreatment files was faster than RaCe files because of less number of files (3 files) when compared to 9 files for the RaCe file system.

3) **Khedmat** *et al in* **2016**[20] The samples were evaluated by cone-beam computed tomography (CBCT) and obturated by using either gutta-percha or GuttaFlow. The results shown that the remaining filling materials inthe ProTapergroup were less than Mtwo group and also the remaining volume for GuttaFlowgroup was less than gutta-percha group regardless of the retreatment system applied.

4) **Ruchi Gupta** *et al* in **2015**[21] The results showed that the maximum amount of obturating material in Calamus group followed by Thermafil and Lateral Compaction groups and minimum voids were seen in Calamus obturation technique. They concluded that the 3D obturation was best with Calamus when compared to Thermafill and lateral condensation.

5) **A.Keles** *et al* in **2014**[22] The root canals were filled with Cold Lateral Compaction or Warm Vertical Compaction technique. The results showed that, no obturation technique were totally void free. But, Warm Vertical Compaction showed significantly greater volume of gutta-percha in root canal and they also showed significantly lower percentage of voids than Cold Lateral Compaction technique

6) **Shanol** *et al* in **2014**[23] They compared the volume percentage of root canals in apical, middle and coronal third individually as well as total volume. The results concluded that, at the apical third all the groups showed 100% of percentage of volume and single cone group showed least percentage of volume at the middle third of the root canal.

7) **Wolf** *et al* in **2013**[24] Each group was obturated by BeeFill system in combination with Sealapex, RoekoSeal and 2Seal. Results showed that silicon based sealer RoekoSeal shows significantly less voids and gaps than other materials tested. In the apical region the amount of voids and gaps was significantly higher. They

concluded that none of the root canal-filled teeth were free of voids. Teeth obturated with RoekoSeal had the highest quality of obturation.

8) **Rodig** *et al* in **2012**[25] Using micro-CT imaging, they calculated the percentage of residual filling material in the root canal as well as the amount of dentine removal. Results showed that D-RaCe instruments were significantly more effective than ProTaper Universal Retreatment instruments and Hedstrom hand files.

9) **Ansari** *et al* in **2011**[26] They analysed the radiographic quality of Cold Lateral Condensation and thermoplasticized injectable gutta-percha techniques. The radiographs were examined by an observer. The results showed that there was no difference in Obtura II and cold lateral compaction regarding apical termination of obturation and post obturation voids.

10) **Anbu** *et al* in **2010**[27] They studied the efficacy of various obturation techniques using spiral computed tomography. They used Lateral Compaction, Thermafill, Obtura II, and System B techniques. The volume of each canal was measured using spiral CT and the percentage of obturated volume (POV) was calculated. Voids were seen in all groups. It was concluded that System B and Thermafill showed the highest percentage of filled volume.

11) **Kandaswamy** *et al* in **2009**[28] The results showed that the free-flow obturation technique had the maximum volume of obturation, followed by vertically

condensed thermoplasticized technique and the least volume of obturation was observed in the Cold Lateral Condensation technique.

12) **Mohammad** *et al in* **2009**[29] They studied the percentage of volume of voids and gaps in root canals which were obturated with variety of obturation materials by using micro computed tomography. The roots were scanned with micro-CT and the volume calculated. The percentage of gaps and voids were then calculated. The results showed that none of the groups were voids free. Roots filled with gutta-percha groups had lesser voids and gaps compared to the roots filled with other groups.

13) **Barletta** *et al in* **2008**[30] They compared K-type hand instrumentation, K-type reciprocating instrumentation and ProTaper rotary instrumentation. The results showed that the most effective method for removal was reciprocating instrumentation and least effective method was manual instrumentation. They also concluded that CT scanning was a reliable method for assessing the obturation removal techniques.

14) **Giuliani** *et al* in **2008**[31] They compared the efficacy of ProTaper Universal retreatment system with Profile 0.06 and K-file hand instruments in retreatment. The roots were longitudinally sectioned and analysed by taking photographs. The results showed that ProTaper Universal System provided better results for removing filling materials than other two groups. Whereas the group ProFile yielded good root canal cleanliness than hand instruments.

15) **Barletta** *et al* in **2007**[32] They compared Endo-Gripper reciprocating system and Profile .04 rotary systems for removal of root canal filling material from curved root canals using computed tomography. Results showed that, neither the two systems completely removed the root canal filling material and no significant differences were observed between the reciprocating instrumentation and rotary systems. They also concluded that by using the CT software, we can outline the precise remnants of filling material and calculation of its volume.

16) **Gergi R** *et al* in **2007**[33] done a study titled as Effectiveness of two nickel-titanium rotary instruments and a hand file for removing gutta-percha in severely curved root canals during retreatment: an ex vivo study. Each group they instrumented with Hedstrom files, ProTaper and R-Endo respectively. The results showed that the percentage of remaining filling material in the entire root canal system did not reveal any significant differences between the methods of removing filling material. The apical third had the most remaining filling material when compared with middle and cervical thirds. They concluded that all instruments left filling material inside the root canal wall. ProTaper and R-Endo rotary instruments were inadequate for the total removal of filling material from the root canal system.

17) **De oliveira** *et al* in **2006**[34]did a study on "*Comparison Between Gutta-Percha and Resilon Removal Using Two Different Techniques in Endodontic Retreatment".* One group was filled with gutta-percha and AH 26 sealer and other group was obturated with Resilon cone with Epiphany sealant using lateral condensation technique. They used retrieval methods such as K3 files and Liberator files.The

results shown that the group filled with Resilon/Epiphany retreated by K3 files demonstrated the least residual filling material.

18) **Masiero** *et al* in **2005**[35] compared the "*Effectiveness of different techniques for removing gutta-percha during retreatment".* They used K-type files, K3 Endo System, M4 system with K-files and Endo-gripper system with k-files. Results shown that, the various comparisons of percentages of remaining material in the entire root canal did not reveal any significant differences between the retrieval systems. They concluded that K3 rotary Niti-instruments were more efficient in removing filling material in apical third than other systems.

19) **Hulsmann** *et al* in **2004**[36] compared Efficacy, cleaning ability and safety of different rotary NiTi instruments in root canal retreatment. Removal of gutta-percha was done with FlexMaster, GT Rotary file, ProTaper and Hedstrom files. Time required for complete removal of gutta-percha was shortest with ProTaper, after that Flex Master and finally hand instruments. Root canal cleanliness was best provided by the use of Flex Master. They concluded that ProTaper NiTi and Flex-Master was efficient and time-saving instruments for retreatment.

20) **Gencoglu** *et al* in **2003**[37] They compared the quality of core-to-sealer ratios for Soft Core and Microseal obturation techniques. Results shown that Soft Core system produced higher gutta-percha content than the Microseal system.

21) **Da Silva** *et al* in **2002**[38] did A comparative study of lateral condensation, heat-softened gutta-percha, and a modified master cone heat-softened backfilling technique. The results showed that, there were no voids detected in the Thermafil group whereas small voids were seen in lateral condensation and Thermafil as backfilling groups.

22) **Barrieshi** *et al in* **2002**[39]did a study on Effectiveness of Nickel-Titanium Rotary Instruments Versus Stainless Steel Hand File. Retreatment was performed either by using chloroform and K flex files or chloroform and NiTi rotary files (Profile .04 Taper).Results showed that the mean percentage of remaining material in the Stainless Steel group was 13.6% and 15.2% for the rotary group.They concluded that NiTi rotary and Stainless Steel hand files were similar efficiency in removing filling material.

23) **Sae Lim** *et al* **in 2000**[40] evaluated the Effectiveness of ProFile .04 Taper Rotary. Retreatment done by Profile alone, Profile and chloroform and hand files with chloroform. Results shown, that the mean scores in ProFile alone and Profile with chloroform had generally lower scores than conventional hand files with chloroform. They concluded that Profile with or without chloroform seemed to be a viable alternative retreatment method.

24) **James** *et al* in **1999**[41] conducted a study titled Thermafil Retreatment Using a New "System B" Technique or a Solvent". They studied using chloroform and hand file instrumentation in one group and other group retreated with System B

Heat Source. Results showed that, the mean time for retrieval of the plastic carrier was significantly less for System B than for the solvent technique. The difference between the amounts of filling material removing from the root canals 30% and 38% respectfully was not statically significant.

25) **Pierre***et al* in **1998**[42] They analyzed the effectiveness of Nd:YAP laser in endodontic retreatment. To remove sealers and broken instruments Nd:YAP laser irradiation was used, alone or in combination with hand instruments. The results concluded that in combination with hand instruments the Nd:YAP laser is an effective tool for root canal preparation and in Endodontic retreatment.

26) **Wilcox** *et al* in **1994**[43]compared Thermafil Versus Laterally Condensed Gutta-percha. The remaining gutta-percha in the root canal was measured using photography method. Results shown that Thermafil group resulted in significantly more remaining gutta-percha in coronal portion than the lateral condensation group. The difference in remaining gutta-percha in the middle and apical areas of the Thermafil group was not statistically different from the lateral condensation group

27) **Carmen** *et al* in **1990**[44]evaluate The Sealing Ability of Thermafil Obturation Technique. The samples were obturated with Thermafil technique and control group were obturated with Lateral condensation method. All teeth were suspended in black India ink. Results shown that the measurements for Linear dye leakage for lateral condensation leaked significantly less than the samples that obturated with Thermafil technique.

MATERIALS AND METHODS

Materials used in the study

a. Saline - Baxter, India Pvt. Limited, Tamil Nadu, India.

b. 5.25% NaOCl - Azure Laboratories Pvt. Ltd., Maharastra, India.

c. 17% EDTA - AvuePrep, Dental Avenue Pvt.Ltd.,Maharastra, India.

d. ProtaperGuttapercha - F4 size, 2% guttapercha–Dentsply, Switzerland.

e. Guttaperchapoint size15-40- Diadent International, Canada.

f. Accessory cones- Diadent International, Canada.

g. AH 26 Plus root canal sealer - DentsplyDeTrey, USA.

h. Paper points -Hygienic, Coltene, USA.

i. CavitG - 3M ESPE, Germany.

j. Endosolv- Prime Dental.

Equipments/Instruments used in the study

a. Micromotor straight hand piece - NSK, Nakanishi, Japan.

b. Diamond Disc - Axis dental, Kavo Kerr, Germany.

c. High Speed airotor hand piece - NSK, Nakanishi, Japan.

d. Metal Scale -Marsman, India.

e. EndoBloc-Dentsply, Maillefer, Switzerland.

f. Endo access bur -Dentsply, Maillefer, Switzerland.

g. K files - ISO size No. 10 to 40 - 25mm Mani Dental. Inc., Japan.

h. Digital Radiograph - Sophix 2 satelec, India.

i. X-Smart Plus -Dentsply, Maillefer, Switzerland.

j. ProtaperNiTi rotary instruments SX, S1, S2, F1, F2 -Dentsply, Maillefer, Switzerland.
k. Spreaders 15-40 - Mani Dental. Inc., Japan.
l. Beefil two in one - VDW GMBH MunhenC,Germany.
m. Protaper retreatment file - D1, D2, D3 - Dentsply Maillefer, Switzerland.
n. D-RaCeretreatment file - DR1, DR2-FKG Swiss Endo.
o. MTwo retreatment files - R1, R2, R3 - VDW, Munich, Germany.
p. CBCT -Kodak CS9300 equipment - Care stream Healthcare India Pvt. Ltd.
q. 3D software- Kodak CS 3D Imaging.

Inclusion criteria- Single rooted mandibular premolars, freshly extracted for therapeutic Purposes, stored in saline and used within three months of extraction.

Exclusion criteria - Fractured teeth, more than one root canal, resorption, open apices, Caries, obturated teeth, curved rooted teeth.

METHODOLOGY

SAMPLE COLLECTION

Ninety (90) single rooted freshly extracted mandibular premolars were collected from the department of Oral and Maxillofacial Surgery, Rajas dental college, Kavalkinaru from patients who had undergone therapeutic extractions. All samples were analyzed with digital radiograph (Satelec, Acteon, France) in buccal and proximal directions for confirming the existence of single straight canal, fully formed apex, no signs of internal resorption, calcification or previous endodontic therapy, caries and restoration or presence of dentin pins.

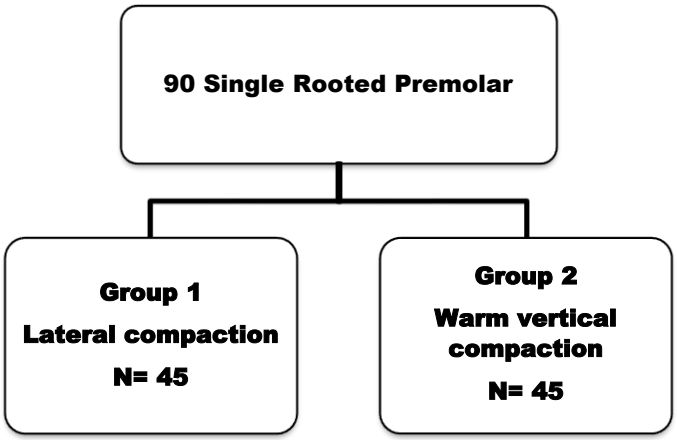
SAMPLE PREPARATION

All the collected samples were then washed thoroughly in running water for two minutes. The organic debris which were adherent to root surface were removed by treating the samples with 17% Ethylene DiamineTetra acetic Acid (EDTA) for five minutes, followed by 3% Sodium Hypochlorite (NaOCl) for five minutes and then immersed in Hydrogen Peroxide (H_2O_2) for 1 hour. Any calculus or soft tissue remnants on the root surfaces were removed using a Gracey curette. Then the prepared samples were then stored in Normal Salineat37ºC and at 95% humidity for a period of 15 days.

ROOT CANAL PREPARATION

The samples were decoronated by using a diamond disc(Axis dental, Kavo Kerr, Germany) to attain a 15mm of standard root length and a reference point. After this, a conventional access cavity was prepared using Endo access bur (size-2, Dentsply Maillefer, Switzerland) using a high speed hand piece (NSK Corporation, Japan). A size 15 K file (Mani inc, India) was introduced into the canal space until the tip of the file was visible at the root apex andthe length of the root canal was estimated .The working length was confirmed at 0.5 mm short of the estimated measurement. After which the working length were confirmed radiographically (bisecting angle technique) by using Ingles method. Then the samples were randomly allocated into two main groups of 45 samples in each

GROUPING FOR OBTURATION



GROUP 1(N=45) LATERAL COMPACTION

A 10size k file was placed into the root canal and the working length was determined by subtracting 1mm from this length. The root canals was prepared using crown down technique with k hand files till size 40. During preparation each canal was irrigated with 2ml of 5.25%NAOCL, 17% EDTA and a final rinse with normal saline. Root canals were coated with AH Plus sealer using lenturo spiral. The root canals were obturated using lateral compaction technique with # 40 gutta-percha point as master gutta-percha and accessory points using AH Plus sealer.

GROUP 2 (N=45) VERTICAL COMPACTION

The root canals were instrumented in sequence with Protaper universal system according to the manufacture instructions. The coronal two third of root canal were prepared with shaping files SX, S1.Cleaning and shaping of root canal were done with F1, F2 and F3. During preparation each canal was irrigated with 2ml of 5.25%NAOCL, 17%EDTA and final rinse with saline. The root canal was dried with a paper points. A F3 size master

cone was coated with AH Plus root canal sealer was placed inside the canal. The excess gutta-percha was removed with heated instrument and the apical third was filled with warm vertical compaction using heat carrier (down packing) and the coronal two third was filled with warm gutta-percha injected by backfill handpiece following the manufacturing instructions in the root canal.

After obturation a primary CBCT was taken to assess the total volume of obturation material in both groups.

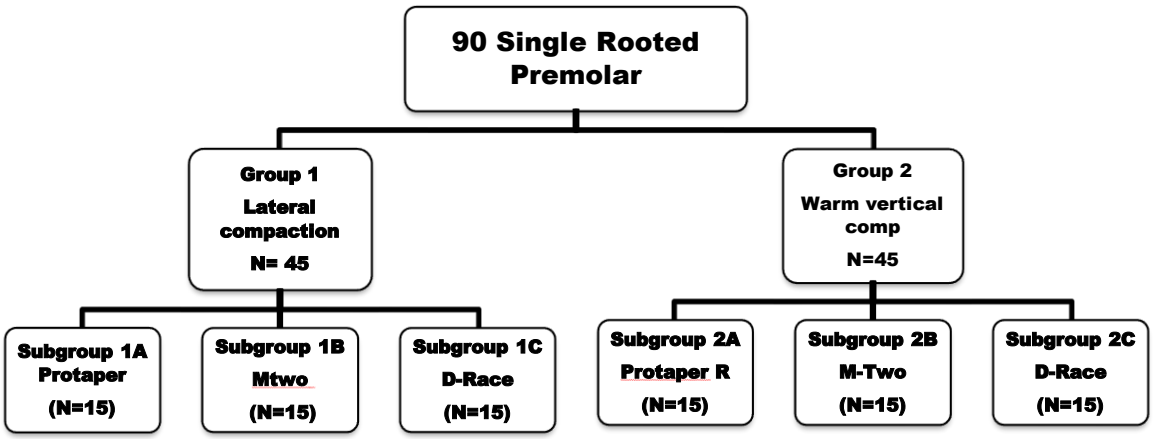
PREOPERATIVE CBCT SCANNING

A primary pre-operative CBCT images were obtained using CBCT scanner (Kodak CS 9300) with a FOV of 4 x 4cm, a tube voltage of 90 kvp and a current of 5mA was used under the guidance of expert operator.The specimens were fixed in mounting foam and placed on the chin rest of Kodak CS9300 for image attainment. By using Kodak CS 3D software the images taken by the scanner were reconstructed three dimensionally so as to view in different directions and slices. The axial, coronal and sagittal view of the entire root canal space was then analyzed. Then the area of the root canal in each slice was calculated from the linear measurement tool from the software. This 15mm root length with of slice thickness of 0.5 mm was evaluated separately under the guidance radiology expert. Then the volume (R) of each slice was calculated.

$$\frac{\text{Area of remaining filling material} \times 100}{\text{Area of canal wall}} = \text{Area of remaining filling material (\%)}$$

GROUPING OF SAMPLES FOR RETREATMENT

After the primary CBCT analysis two groups (Group 1 and Group 2) were randomly sub divided three sub groups with 15 samples in each.



GROUP 1A & 2A: PROTAPER UNIVERSAL RETREATMENT GROUP (N = 15)

ProTaper Universal Retreatment (PTUR) instruments were used to remove the filling material in a crown-down technique as follows: D1 (size 30, .09 taper) for the cervical third, D2 (size 25, .08 taper) for the middle third, and D3 (size 20, .07 taper) for the apical third until the working length was reached. The instruments were used with the electric motor at a speed 300 rpm and torque of 2 Ncm^{-1}

GROUP 1B & 2B: MTWO RETREATMENT GROUP (N = 15)

Root canals were instrumented in a simultaneous retreatment technique to the working length using Mtwo (size 15, 0.05taper) in a brushing action with lateral pressing movements. Progression of the rotary file was performed by applying slight apical pressure and frequently removing the files to inspect the blades and continued to a size 25, 0.05taper and was used at the speed of 300 rpm/min and a torque of 1.2 Ncm^{-1}

GROUP 1C&2C: D-RACE RETREATMENT GROUP (N = 15)

D-RaCe retreatment instruments were used as follows: DR1 (size 30, .10 taper) at a speed of (1000 rpm and torque of 1.5 Ncm^{-1}) for the cervical third and beginning of the middle third and DR2 (size25, .04 taper) at 600-rpm speed and a torque of 0.7 Ncm^{-1} at the working length.

POST OPCBCT SCANNING

After retreatment the prevalence of the residual filling materialin each group was evaluated by estimating in the root canal space by obtaining post op CBCT. Then CBCT data were imported to Kodak CS 3D imaging software. The volume of residual filling materialinside the canal was calculated with the following equation

$$\frac{\text{Area of remaining filling material}}{\text{Area of canal wall}} \times 100 = \text{Area of remaining filling material (\%)}$$

The Data was collected and subjected to statistical analysis.

1.INTRODUCTION

Fig 1.1. 90 Single Rooted Mandibular Premolars

Fig 1.2. Preoperative RVG

FIG 2.1 MATERIALS USED IN THIS STUDY

3. ARMAMENTARIUM USED IN THIS STUDY

Fig 3.1

Fig 3.2.X-Smart Plus

Fig 3.3.Beefil Two In One

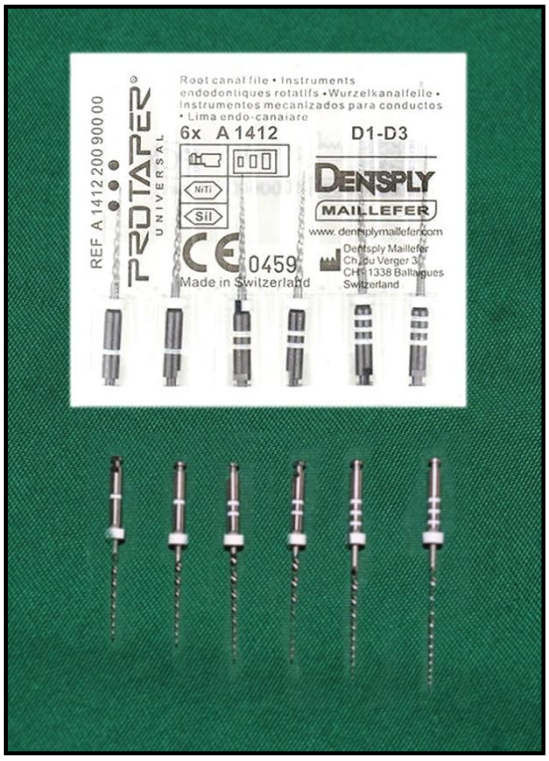


Fig 3.4.Protaper retreatment file – D1, D2, D3

Fig 3.5.D-RaCe retreatment file –DR1, DR2

Fig 3.6.MTwo retreatment files – R1, R2, R3

4.SAMPLE PREPARATION

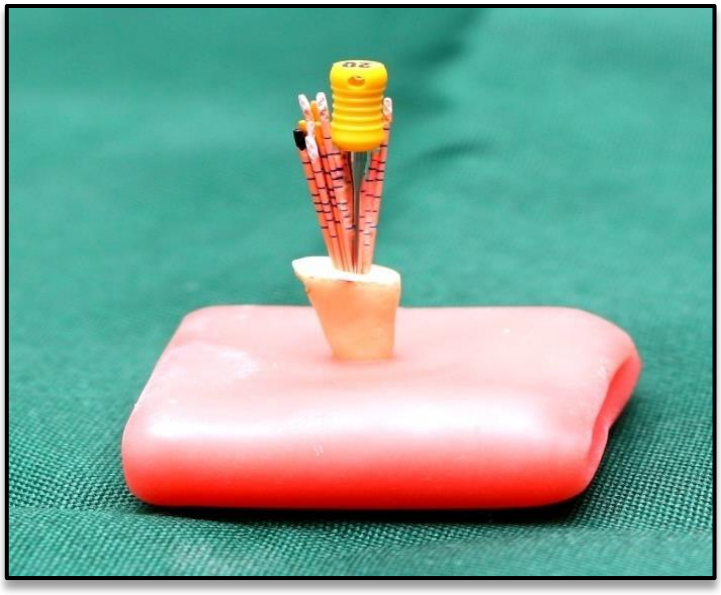


Fig 4.1Lateral Condensation

Fig 4.2.Warm Vertical Condensation

Fig 4.3.Lateral Condensation -RVG

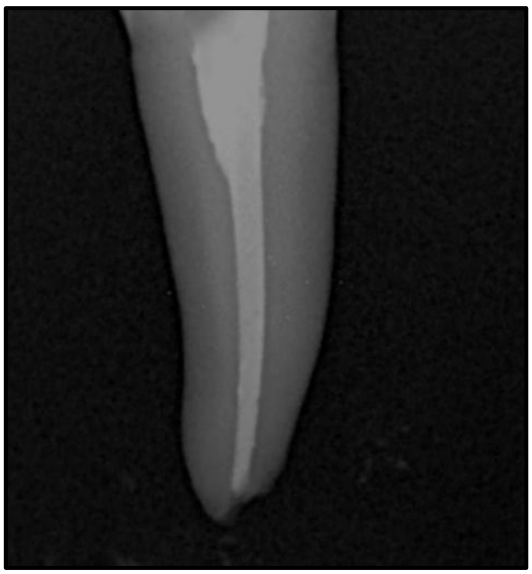


Fig 4.4.Warm vertical Condensation-RVG

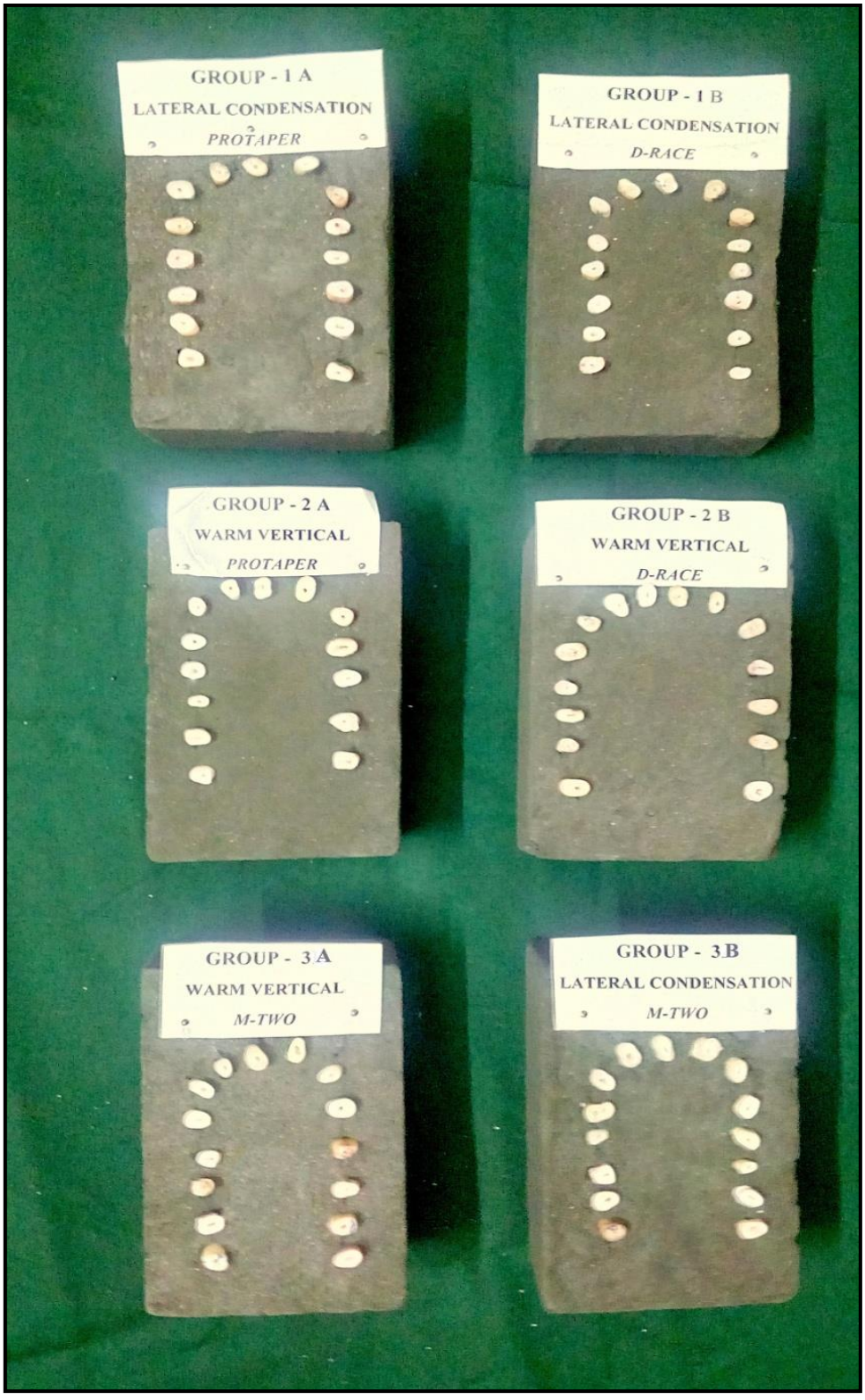


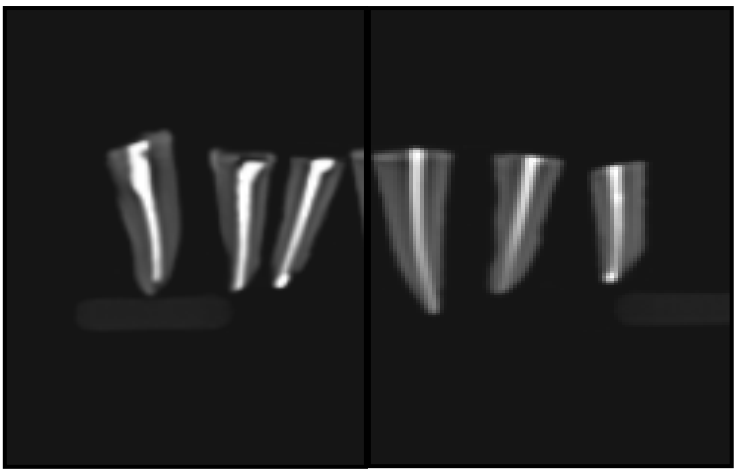
Fig 4.5.Arranged Samples (90)

5. IMAGE ACQUISITION

Fig 5.1.Kodak CS9300

Fig 5.2. Sample placed on CBCT

Pre-Op CBCT Image



Lateral Compaction **Vertical Compaction**

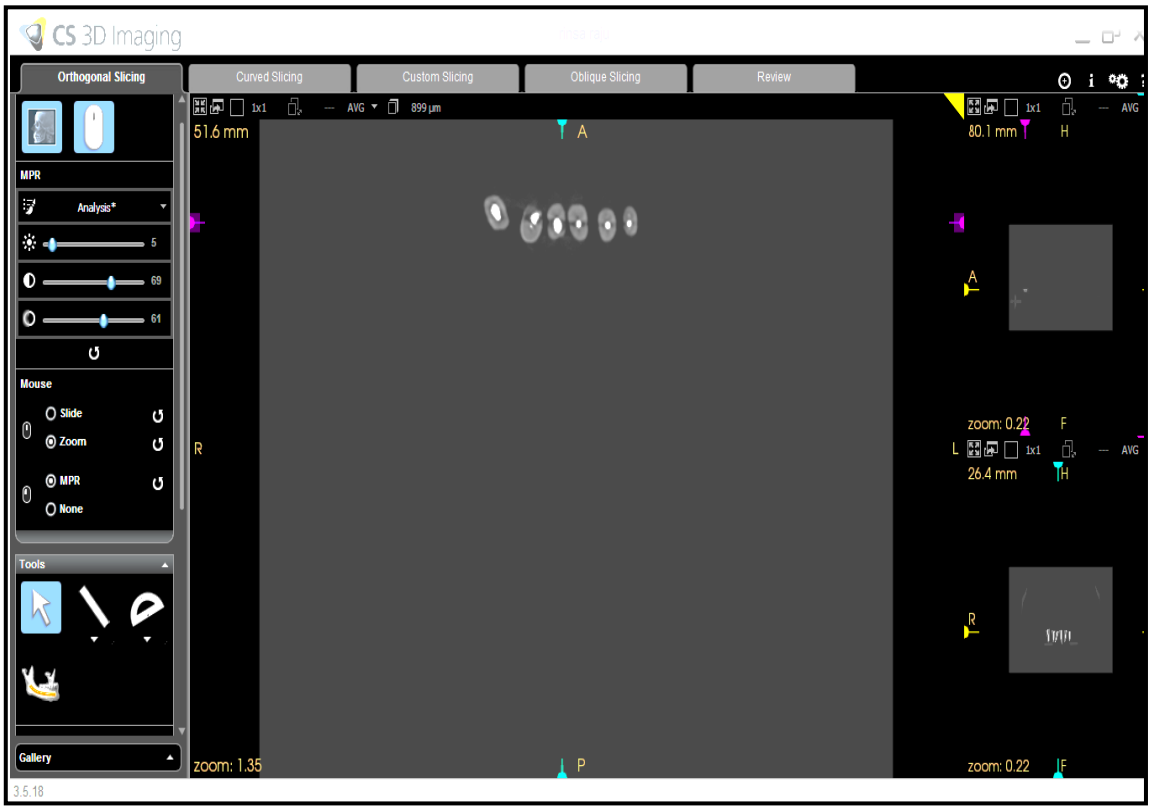
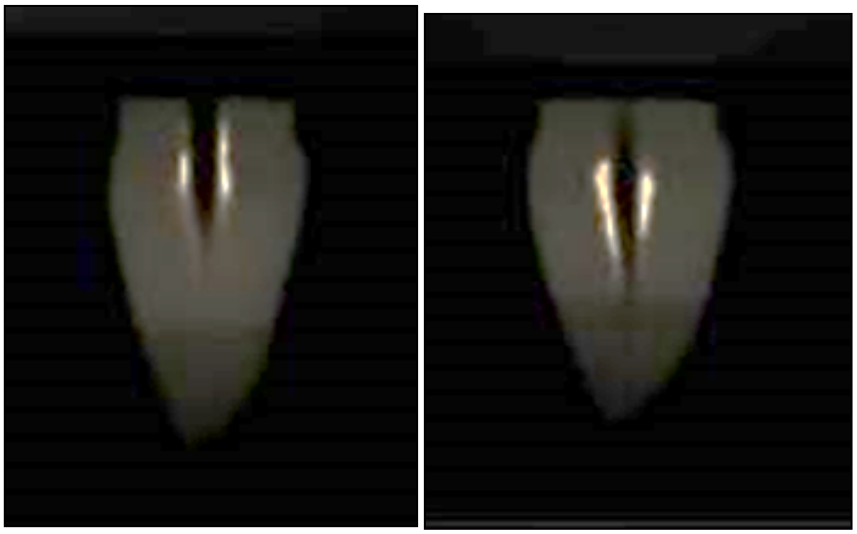


Fig 5.3.Axial View

Post-Operative CBCT Image



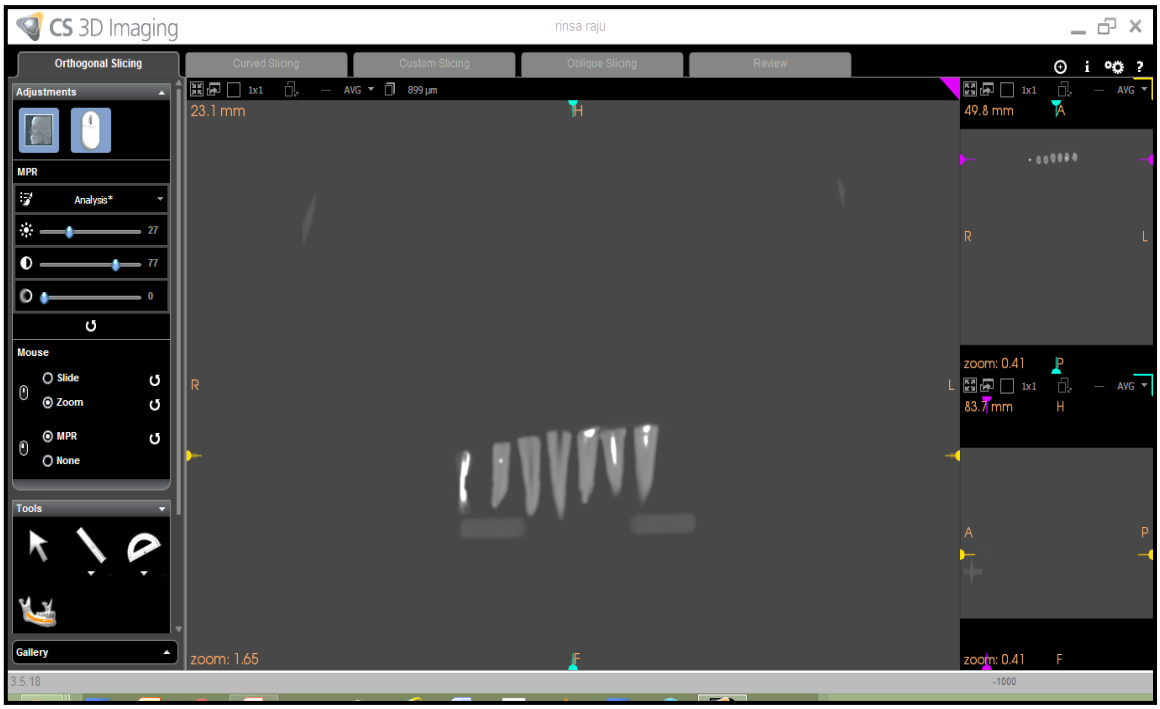


Fig 5.4.Axial View

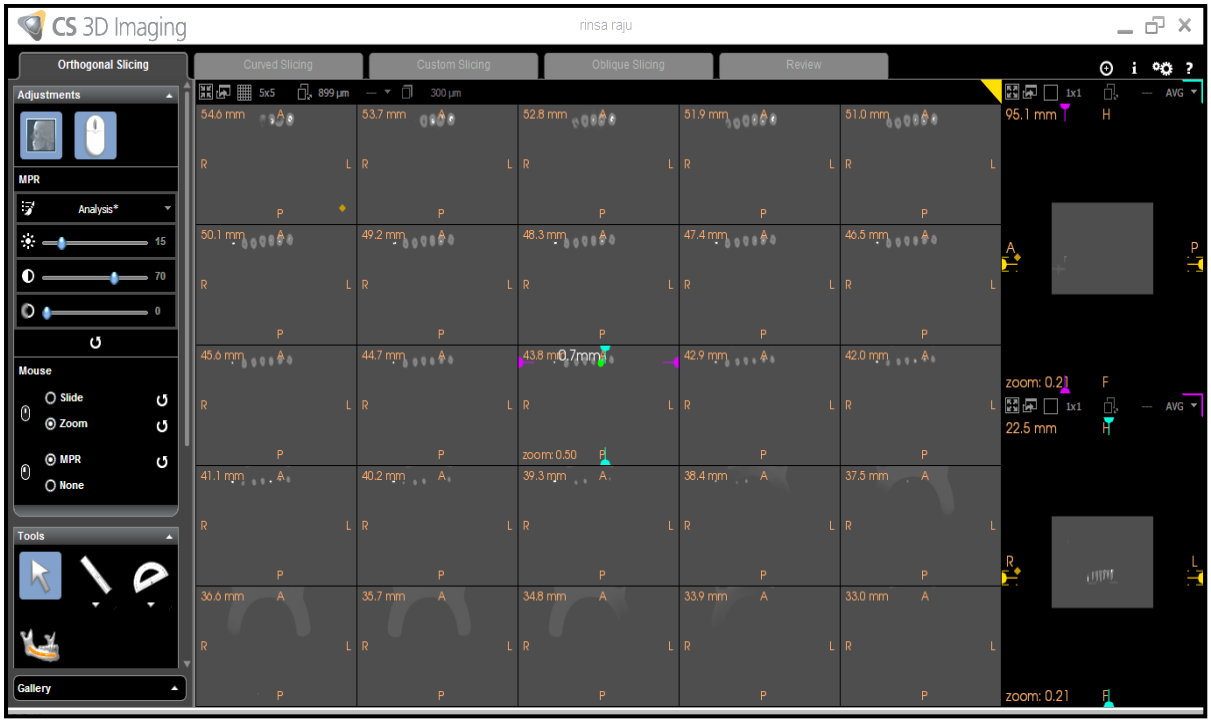


Fig 5.5.30Slices

Fig 5.6.Void Radius Calculation

STATISTICAL ANALYSIS

The data entry was done with Microsoft office Excel work sheet (2010). Data were analyzed using Statistical Package for Social Sciences (SPSS) Software version 21(IBM Statistics). Descriptive statistics include mean and standard deviation (SD) for all the samples tested. The mean value for the lateral compaction, warm vertical compaction and the three retreatment systems was calculated separately for all the groups. Statistical analysis used in this study were ANOVA and LSD post hoc test. The test to find out the influence of initial obturation with post retreatment was done with using ANCOVA test (Analysis of co-variance). P value less than 0.05 was considered as statistically significant.

RESULTS

Table no.1: Mean and standard deviation of the pre-op root canal filling by obturation method wise

Method	No.	Mean	SD	t-test value	P-value
Lateral Compaction Method	45	41.46	1.73	-6.270	<0.001
Warm Vertical Condensation	45	43.42	1.16		

Table no.1 shows the mean and standard deviation of the area of the root canal filling by obturation technique wise. The purpose of this table to find out whether any significant variation exists in the area of filling between the two obturation methods. Hence student t-test has been applied to compare the two methods of obturation.

The mean filling area has been 41.46cm^2 and 43.42cm^2 respectively for the Lateral Compaction Method and Warm Vertical Condensation methods. The significant p-value reveals that area of filling has been statistically higher in the method of Warm vertical condensation technique. The above mean values are also shown in the figure no.1.

Fig. No.1: Mean with Standard deviation of filling area by obturation technique wise

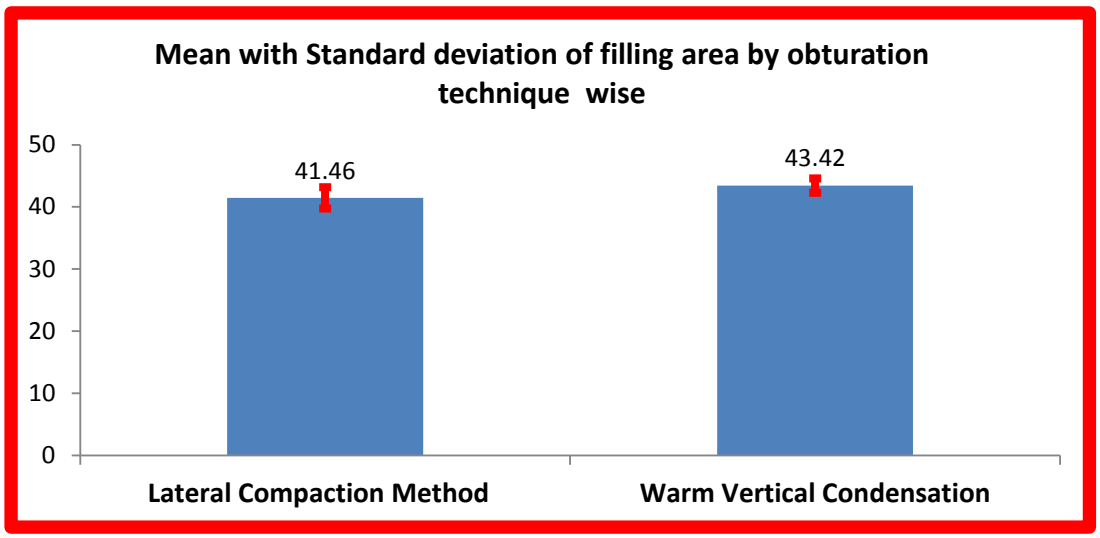


Table no.2: Mean and Standard deviation of the remaining filling area by removal file type wise

File Type	No.	Mean	SD	ANOVA-F value	P-value
Pro-taper	30	2.5170	1.04978	22.989	<0.001
D-race	30	4.2807	1.03747		
M-two	30	3.6107	0.96156		

Fig. No.2: Mean with standard deviation of the remaining material area by retrieval file system wise

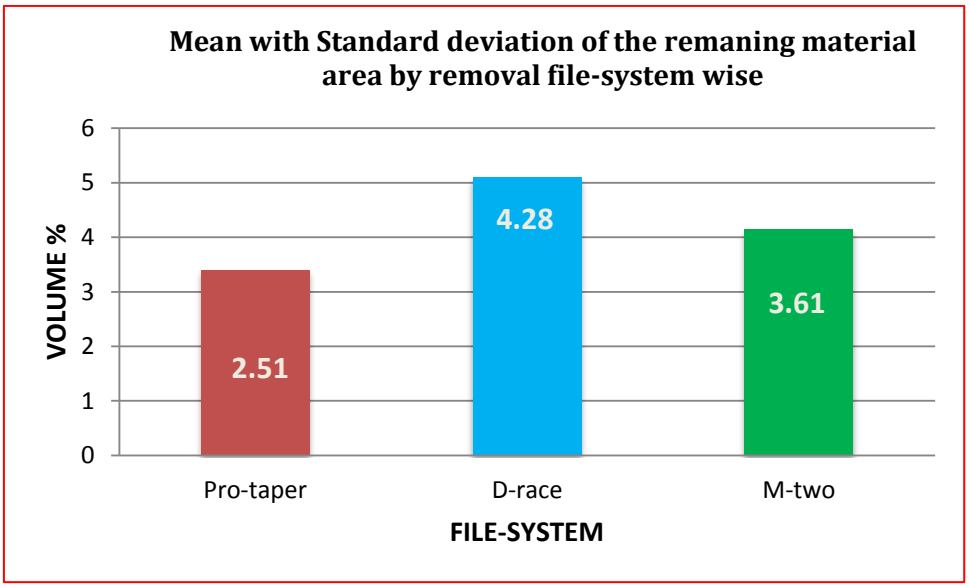


Table no.2 shows the post-op mean and standard deviation of the remaining area by retrieval file system wise. The purpose of this table is to find out whether remaining area has been same for the three retrieval file types irrespective of the method of obturation. Hence, one way ANOVA test has been applied, to compare the three groups i.e. the 3 file system.

After the material retrieval, the remaining filling area of voids has been 2.51cm^2 , 4.28cm^2 and 3.61 cm^2 respectively for the Pro-taper, D-race and M-two file systems. The significant p-value of the ANOVA test infers that the efficiency of three file systems is statistically different. To find out which of the file system is differ, LSD post hoc test has been applied and the results are shown in table no.2A.

All The three comparisons namely Pro-taper versus D-race, Pro-taper versus M-two and D-race versus M-two are statistically different. It indicates that in the Pro-taper file system,

the remaining filling area has been lesser than other two file systems. In the D-race technique, the remaining filling area has been higher compared to other two techniques.

Now a query comes that this variation in the three file system has been really due to the file systems we have adopted or the pre-op filling area has influence on the remaining area of filling material. The query arises because of the result in table no.1. Hence to clarify this queries, one way ANCOVA test has been applied, the pre-op filling area as a covariate. The result of the ANCOVA test has been shown in table no.2B.

The significant p-value of the "File System" confirms that the three file systems are statistically different and further the significant p-value of the " pre-op filling area " infers that remaining filing area after the retrieval has been highly influenced by pre-op filling area.

Suppose the pre-op filling area has been similar for all the subjects, what will be the remaining filling material area after the removal has been shown in the table no.2C. The estimated marginal filling area after applying the three file systems has been. 2.68, 4.13 and 3.59 respectively for the Pro-taper, D- race and M-two file systems. Further the estimated marginal mean values have been compared with the LSD post hoc test. The significant p-value of all the three comparisons ensure that if removal of filling material has been carried out by pro-taper system, the area remaining with filling material has been lesser than the other two file systems and in the D-race file system the area remaining with filling material has been higher than M-two file system.

Table no.2A: LSD Post hoc test value for removal by file system wise

Comparison		Mean difference	Standard Error	P-value
Pro-taper	D-race	-1.76367*	.26259	<0.001
Pro-taper	M-two	-1.09367*	.26259	<0.001
D-race	M-two	-.67000*	.26259	0.012

Table no.2B: ANCOVA test result for removal after controlling with the pre-op filling values

Source	ANCOVA test result	
	F-value	P-value
Pre-Op filling area	18.348	.000
File-System	16.984	.000

Table no.2C: Estimated Marginal Mean values and its comparisons using post hoc

File-System	Estimated Mean value	Comparison		Mean difference	Standard Error	P-value
Pro-taper	2.684	Pro-taper	D-race	-1.447*	.251	<0.001
D-race	4.130	Pro-taper	M-two	-.911*	.244	<0.001
M-two	3.595	D-race	M-two	-.535*	.242	0.029

Since the pre-op filling area has influence on the removal of filling material area (table no.2b), it makes to compare the three file systems for the two obturation methods separately. Hence it has been compared and the results are shown in table no.3 and table no.4.

Lateral Compaction Method

Table no.3: Mean and Standard deviation of the remaining filling area after the removal by 3 File systems for Lateral Compaction Method

File-Systems	No.	Mean	SD	ANOVA-F value	P-value
Pro-taper	15	3.4127	.46783	24.158	<0.001
D-race	15	5.1027	.57895		
M-two	15	4.1507	.88495		

Fig.No.3: Mean remaining area by 3-file systems for Lateral Compaction method.

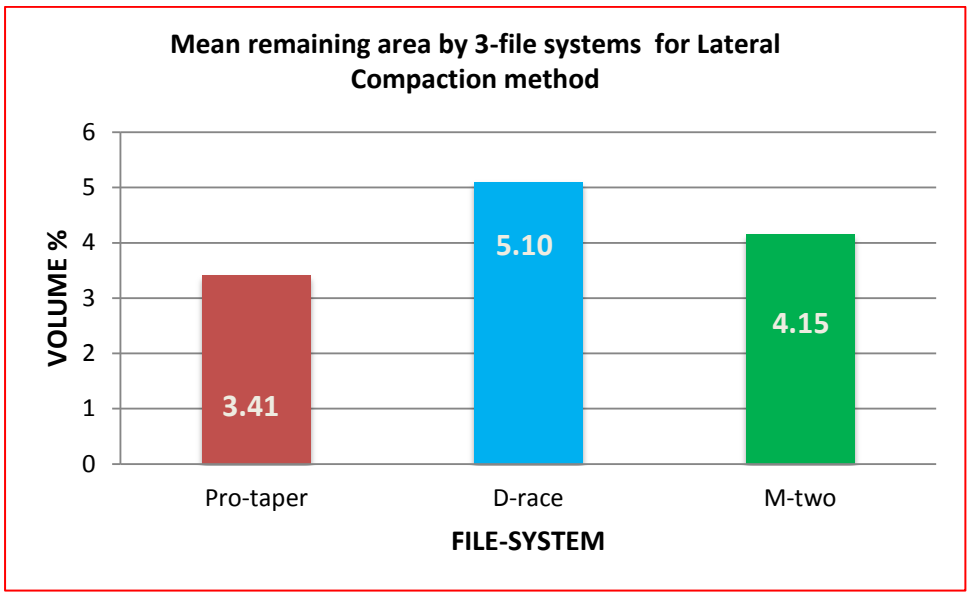


Table no.3 shows the mean and standard deviation of the remaining filling area by 3-file systems for those samples obturated with Lateral Compaction Method. The purpose of this table is to compare the three file systems are same for those tooth filled with Lateral Compaction Method.

The mean remaining area after 3-file systems used has been 3.41cm^2, 5.10cm^2 and 4.15cm^2 respectively for the pro-taper, D-race and M-two treatments. One way ANOVA test has been applied to compare the above three mean values. The significant p-value reveals that the remaining filling area has been statistically different for the three 3-file systems used for those tooth filled with Lateral Compaction Method.

The ANOVA test result gives there is a significant variation between the three 3-file systems but it does not infers which of the file system are statistically different. Hence, Post hoc test has been applied. Here, LSD post hoc test has been preferred. The results of the LSD Post hoc test have been shown in table no.3A. The significant p-value of the three comparisons clearly indicates all the three file systems used are different and when treated with Pro-taper file system, the remaining area with filling material has been lesser than the other two file systems and M-two file system has the remaining filling material lesser than the D-race file system .

Since the filling area has been different for each teeth treated with lateral compaction method. Now, a query comes the difference is really due to the three file systems used or due to the influence of pre-op filling area. Hence ANCOVA test has been applied to compare the three file systems after controlling the pre-op filling area. The results of the ANCOVA test have been shown in table no.3B. The non-significant p-value of the pre-op filling area indicates that pre-op filling area is not influencing on the remaining filling area

after the three file system were used. The significant p-value of the retrieval system confirms that the difference is due to the removal file systems only.

For the completion of ANCOVA analysis, the estimated marginal mean values for each file system has been calculated and compared between them. The result of the marginal estimated values and its comparisons are shown in table no.3C. The significant p-value of the three comparisons ensures that Protaper removal system is superior to the other two techniques and M-two is better than D-race system when the tooth are filled with lateral compaction method.

Table no.3A: LSD Post hoc test value for removal by three file-system wise for Lateral Compaction Method

Comparison		**Mean difference**	**Standard Error**	**P-value**
Pro-taper	D-race	-1.69000	.24378	.000
Pro-taper	M-two	-.73800	.24378	.004
D-race	M-two	-.95200	.24378	.000

Table no.3B: ANCOVA test result for removal after controlling with the pre-op filling values for Lateral Compaction Method

Source	**ANCOVA test result**	
	F-value	**P-value**
Pre-op filling area	.241	0.626
File-system	21.646	<0.001

Table no.3C: Estimated Marginal Mean values for the Lateral Compaction Method and its comparisons using LSD post hoc test

Technique	Estimated Mean value	Comparison		Mean difference	Standard Error	P-value
Pro-taper	3.391	Pro-taper	D-race	-1.738*	.265	<0.001
D-race	5.129	Pro-taper	M-two	-.755*	.249	.004
M-two	4.146	D-race	M-two	-.982*	.254	<0.001

Warm Vertical Condensation

Table no.4: Mean and Standard deviation of the remaining filling area after retrieval by 3-file systems wise for Warm Vertical Condensation

File-Systems	No.	Mean	SD	ANOVA-F value	P-value
Pro-taper	15	1.6213	.58727	32.497	<0.001
D-race	15	3.4587	.66819		
M-two	15	3.0707	.71221		

Fig. No.4: Mean remaining filling area by 3-file systems for the tooth filled with Warm vertical condensation method.

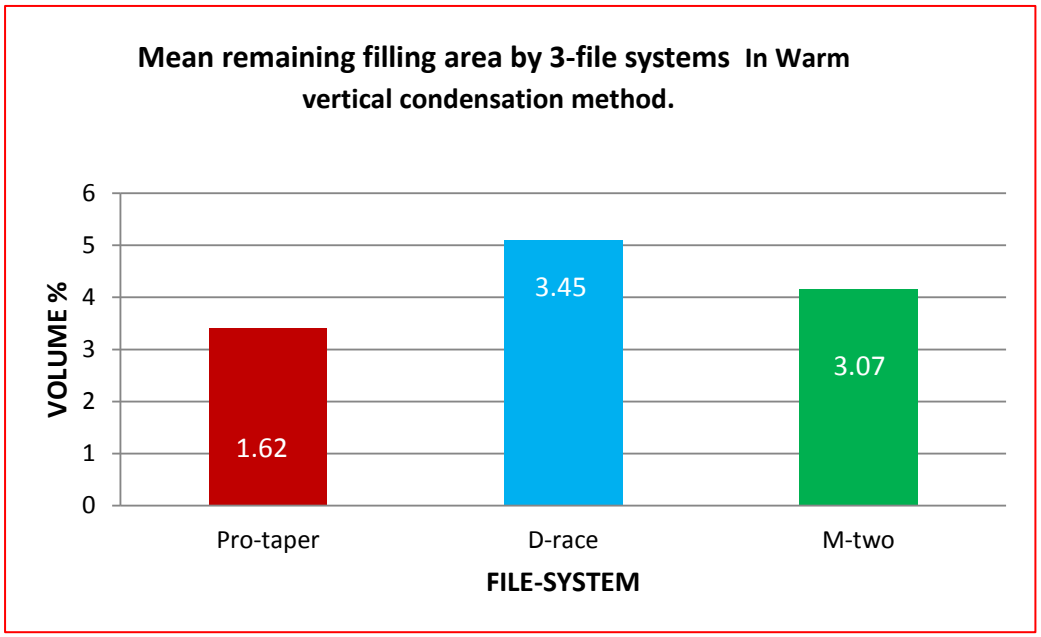


Table no.4 shows the mean and standard deviation of the remaining filling area by removal file system wise for those filled with Warm Vertical Condensation method. The purpose of this table is to compare the three file systems are same for those tooth filled with Warm Vertical Condensation method.

The mean area remaining after the three file systems has been 1.62cm2, 3.45 cm^2 and 3.07 cm^2respectively for the Pro-taper, D-race and M-two. One way ANOVA test has been applied to compare the above three mean values. The significant p-value reveals that the remaining filling area has been statistically different for the three file systems.

The results of the LSD Post hoc test have been shown in table no.4A. The significant p-value of the two comparisons Pro-taper versus D-race and Pro-taper versus M-two clearly indicates Pro-taper technique has less mean remaining filling area than the other two techniques. The non-significant p-value of the comparison between the D-race and M-two

techniques infers that the remaining filling area has been similar for the two removal techniques.

ANCOVA test has been applied to compare the three file systems after controlling the pre-op filling area. The results of the ANCOVA test have been shown in table no.4B. The non-significant p-value of the pre-op filling area indicates that remaining filling area by the three removal file systems is not influenced by the pre-op filling area, which is filled with warm vertical condensation method. The significant p-value of the file system confirms that the difference is due to the removal systems only.

The result of the marginal estimated values and its comparisons are shown in table no.4C. The results of the three comparisons infers that pro-taper file system is much effective than the other two removal systems.

Table no.4A: LSD Post hoc test value for removal by file system wise.

Comparison		**Mean difference**	**Standard Error**	**P-value**
Pro-taper	D-race	.99667*	.40088	.017
Pro-taper	M-two	.90000*	.40088	.030
D-race	M-two	.09667	.40088	.811

Table no.4B: ANCOVA test result for removal after controlling with the pre-op filling values for Warm Vertical Condensation

Source	ANCOVA test result	
	F-value	**P-value**
Pre-op	.036	.849
File-systems	27.538	.000

Table no.4C: Estimated Marginal Mean values for the Warm Vertical Condensation and its comparisons using LSD post hoc test

File-system	Estimated Mean value	Comparison		Mean difference	Standard Error	P-value
Pro-taper	1.610	Pro-taper	D-race	-1.855	.260	.000
D-race	3.465	Pro-taper	M-two	-1.46*	.257	.000
M-two	3.075	D-race	M-two	-.390	.243	.117

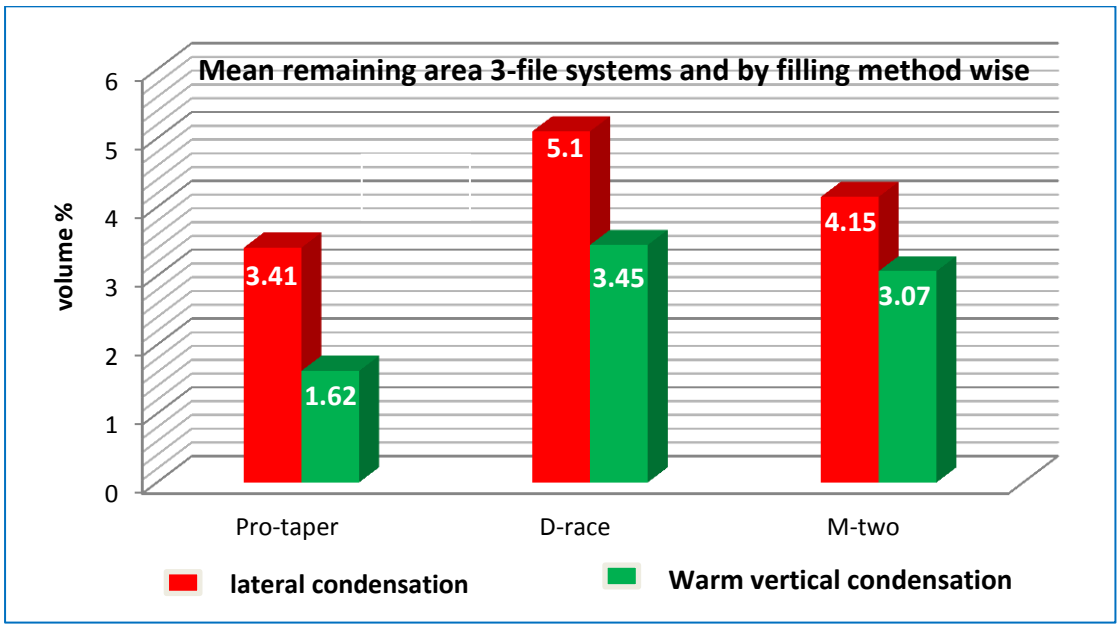
Table no.5: Mean and standard deviation of the remaining filling area by3-file systems and method of obturation wise.

File-system	Obturation method	Mean	SD	Two-way ANCOVA test result		
				Source	**F-value**	**P-value**
Pro-taper	Lateral Compaction Method	3.41	0.467	Initial filling area	.270	.605
	Warm Vertical Condensation	1.62	0.587	File system	48.581	.000
D-race	Lateral Compaction Method	5.10	0.578	Obturation Method	81.007	.000
	Warm Vertical Condensation	3.45	0.668	File system X Obturation	2.468	.091
M-two	Lateral Compaction Method	4.15	0.884			
	Warm Vertical Condensation	3.07	0.712			

Table no.5 shows the mean and standard deviation of the remaining filling area by 3-file systems and obturation method wise. The purpose of this table is to find out is there any interaction effect exists between the by 3-file systems and obturation method .i.e. to assess whether a particular file system is best for a particular obturation method. Hence, Two way ANCOVA test has been applied after controlling with the pre-op filling area. The non-

significant p-value of the interaction effect “file systems X obturation” infers that effect of the three file systems has been similar for the two methods of obturation.

Fig. No.5: Mean remaining area by 3-file systems and by obturation method wise



DISCUSSION

Preservation of patient's natural dentition is an important outcome in maintaining oral health. For many decades Endodontic treatments have successfully retained compromised teeth which were carious, fractured or traumatized. The main aim of root canal treatment is to obtain a three dimensional obturation of entire root canal space which helps to seal all the portals of entire of microbial systems which leads to a secondary infection. Despite of high success rate in modern endodontic treatments, the procedural errors and operative challenges can lead to treatment failures[45,46].Endodontic failures mainly occur due to the incomplete obturation of entire root canal system. Hence, the long term success of an Endodontically treated tooth based on quality of the obturation[47].According to Yu-Hong, the success of root canal treatment as,the quality of treatment is mainly judged by the apical extent of the root canal filling and presence or absence of voids and also a good treatment was done when the root canal filling is 0–2 mm from the apex[48].

The first major step of retreatment was the complete removal of previous existing filling materials to allow proper cleaning, disinfection and re-filling of entire root canal space. Usually, this can done by using hand files, engine- driven rotary instruments (NiTi) with or without solvents, ultrasonic tips and files and heat-carrying instruments. The use of rotary files facilitates an effective removal of bulk gutta-percha based fillings from the root canal[49]. Hence the present study was done to compare and evaluate the effectiveness of three different gutta-percha removing file systems on two obturation techniques using Cone Beam Computed Tomography (CBCT).

In this present study Ninety (90) single rooted mandibular premolars were collected so as to increase the significance of this study. The samples were randomly allocated into two main groups of 45 samples in each. In group-1 the root canals were prepared by using crown down technique with traditional K type stainless steel files till 40 size and group-2 was prepared with the sequence of engine-driven rotary Protaper universal file systems(F1, F2 and F3). According to Hatton canals prepared with stainless steel instruments were cleaned only superficially and much of the pulp tissue was not removed efficiently. Stainless steel files also create aberrations because of the inherent stiffness of stainless steel and also instrumentation in curved canals results in apical transportation. This makes difficulty in obtaining a successful apical seal[50].Protaper files allow shaping of narrow and curved root canals, without causing any aberrations. It also produces super elastic and shape memory effect. NiTi instruments allow the root canals preparations with fewer procedural errors than conventional stainless steel instruments[51,52].

After Instrumentation all the prepared sample walls were coated with AH Plus sealer. Hermetic sealing of the root canal space is the most expected outcome of any root canal treatment. Gutta-percha does not have any inherent property of adhesion to the root canal walls, this result in microleakage and total failure of the endodontic therapy. So, in order to overcome this drawback, various sealers have been developed. The traditional zinc oxide eugenol sealers have been replaced with latest resin-based, silicone based, MTA sealer and bioceramic sealers[53]. In this study we used gutta-percha along with AH Plus sealer, an epoxy resin based sealer, to achieve proper bonding to the root canal walls. AH plus sealer can be used along with gutta-percha in vertical compaction as well as lateral condensation methods. AH plus sealer shows low contraction and solubility in comparison to zinc oxide eugenol-based and calcium hydroxide based sealer[54]. It has

good tissue compatibility and lasting tightness to the root canal surface. Canal Tightness mainly depends on dimensional stability like expansion, polymerization shrinkage and solubility as well as adhesion to both dentin and inserted cones. Also it provides good radiopacity and easy application[55,56].

In this study we used lateral condensation and warm vertical condensation for obturation.Gutta-percha is the most frequently used material for root canal obturation.It is compressible, inert, tissue tolerant, dimensionally stable, radiopaque and becomes plastic when heated[57]. Most retreatment studies have used teeth filled by cold lateral condensation.Numerous invitro studies have evaluated obturation techniques by comparing different parameters such as length of material filled, gutta-percha density and defect replication[58,59,60]. In this study, the focus was mainly on the volume of obturation in the root canal space. Volume analysis was done by using CBCT. In this study,based on the method of obturation, we divided the 90 samples in two main groups. One group was obturated with lateral condensation and other group was filled with warm vertical condensation method. The result from initial CBCT analysis shows that the mean filling area has been 41.46cm^2 and 43.42cm^2 respectively for the Lateral Compaction Method and Warm Vertical Condensation methods. The significant p-value reveals that area of filling has been statistically higher in the method of Warm vertical condensation technique. Lateral condensation group does not create a homogenous mass of gutta-percha and poorly replicates the prepared root-canal space; it also tends to entrap pools of sealer between the gutta-percha cones. It leaves voids between cones and it may provide a niche for bacteria to survive[61,62]. Warm Vertical Compaction by thermaplasticized gutta-percha provides a good homogenous three dimensional obturation than the other technique used in this study.

Warm vertical condensation has better adaptation to the three-dimensional root canal spaces and exhibited a homogenous obturation[63,64,]. Tamer Tasdemir et al (2009) conducted a study with single cone, Lateral Compaction and Beefill obturation treated with ProTaper or Mtwo files and the results showed that warm vertical compaction has lesser leakage than other two methods[65]. Ho ES et al (2016) compared the density of gutta-percha root fillings obturated with cold lateral compaction, warm vertical compaction and ultrasonic lateral compaction methods[66]. They concluded thatwarm vertical compaction provides superior density of gutta-percha root filling than other two methods. These results are similar in accordance with this study in which, more percentage of obturated material as well as less voids were present in the warm vertical compaction group. Even the quality of obturation was superior in warm vertical compaction group compared to the lateral condensation group.

Various methods have been developed to assess the remaining filling material in root canal space. Methods such as longitudinal splitting with a scoring system, tooth sectioning and analyzing with stereomicroscope or using digital camera, combination of longitudinal & transversal splitting, combination of cleavage and photography in association with radiographic examination.

Limitations of these methods are cleavage and splitting may not be accurate because of some residual material is likely to be lost in this process and radiographic images provides only two-dimensional information of a three dimensional tooth structure. Using recent three dimensional methods such as CT, Micro-CT and CBCT techniques provide volume of remaining filling material in the root canal space very clearly. These methods provides detailed visualization of morphological features without destruction of the tooth

structure and creates a three dimensional image and reproducible data that can be used for the comparison of root canals before and after filling removal. CBCT allows the reproduction of the 3D information, with very less radiation exposure, which is a noninvasive method without the destruction of the tooth sample[67,68,69,70,71].

In this study dental CBCT was chosen for scan because dental CBCT scan was more accurate than digital and conventional two dimensional intraoral techniques. CBCT uses a cone shaped x-ray beam centred on a flat panel sensor for a 360-degree rotation scan around the patients head to acquire a full 3-dimentional volume of data. The advantages of CBCT over conventional tomography are higher image accuracy, easier image acquisition, lower radiation doses, reduced artifacts, shorter scan and reconstruction times and greater cost effectiveness[72]. The principle behind CBCT is, the X-ray beam is conical in shape and divergent with a detector spinning around the area of interest and providing the data cylindrically. The area of interest is called field of view (FOV).A field of view contains millions of voxels, and these are arranged in isotropic (with equal dimension) or anisotropic (with unequal dimension) shape and CBCT uses the isotropic shape.

After image acquisitions data's are processed by CBCT software and the images where reconstructed mainly in three planes sagittal, axial, and coronal planes[73].In this study, the volume of obturation material in root canal before retreatment was calculated by obtaining scanning of the samples with Kodak 9300 CBCT scanner. For each sample, from coronal to apex standard measurement fixed as 15mm. Then 15mm sections were further divided into 30 slices of 0.5mm thickness for each slice. Then the volume of the obturation was calculated form the coronal to the apex using the linear measurements obtained from the scan using Kodak CS3D software. Hiroshi Watanabe et al stated that

CBCT can measure tiny isotropic cubes of about 0.1-0.4 mm[74]. The same procedure was used for calculating the volume of voids after retreatment also. Then the volume percentage of the voids was calculated by using the formula[75].

$$\frac{\text{Area of remaining filling material}}{\text{Area of canal wall}} \times 100 = \text{Area of remaining filling material (\%)}$$

By using one way ANOVA test, we compared the efficiency of three file systems irrespective of the method of obturation. The results after the retreatment were, the area of voids has been 2.51cm^2, 4.28cm^2 and 3.61 cm^2 respectively for the Pro-taper, D-race and M-two file systems. The significant p-value of the ANOVA test infers that the efficiency of three file systems is statistically different.

Recently, the procedures of retreatment have become even more important in Endodontics, replacing surgical methods. Different solvents have been largely used to soften and dissolve gutta-percha in the root canal to facilitate file penetration and removal[76].Hwang C.J.I et al conducted a study to compare the effectiveness of Endodontic solvents to remove endodontic sealers and concluded that the use of proper endodontic solvent makes complete removal of the sealer from the root canal was necessary for successful retreatment[77].

Chloroform was traditionally used as a solvent for gutta-percha removal due to its superior ability to dissolve gutta-percha rapidly. Due to its carcinogenic nature, reported by the International Agency of Research of Cancer the wide use of chloroform has been discontinued. Hence, the use of other solvents such as orange oil, xylene, halothane and tetrachloroethylene has been used in nowadays days for the removal of gutta-percha. Among these solvents, xylene has been found the best dissolving efficacy followed by

orange oil and tetrachloroethylene have the least dissolving efficacy[78]. Because of its slow-dissolving effect and its toxicity on mucosal tissues as suggested by Mushtaq et al, xylene not been used in this study. Hence, easily available solvent, RC Solve (Prime Dental, Mumbai) an orange oil derivative with the main ingredient of D-Limonene has been used in this study. D-Limonene is shown to be non carcinogenic with good amount of biocompatibility on human tissues[79].

Conventionally the removal of gutta-percha using hand files with or without solvent can be a tedious, time consuming process especially when the root filling material is well condensed[80].Jadhavaet al conducted a study and they concluded that H-file group showed maximum amount of gutta-percha within the root canal space and also took more time for removal than rotary files such as Protaper and R-endo.Therefore,the use of rotary NiTi instruments in the root canal retreatment may reduce the working time and decrease patient and operator fatigue[81].

The time period required for filling material setting, the literature shows lack of consensus with period ranging from 1 week to one year. In this study, a period of 2 week was chosen for the removal of gutta-percha and sealer i.e. for the retreatment procedure[82,83].

Recently specially designed NiTi instruments developed for the removal of filling materials have been marketed, including ProTaper retreatment files, D-Race retreatment files, Mtwo retreatment files and R-Endo retreatment files[84].

In this present study, ProTaper retreatment files (DentsplyMaillefer, Switzerland.),D-Race (Swiss Endo) and Mtwo retreatment (VDW, Munich, Germany) files have been used for the retreatment procedure.

The root canal filling in group 1A and group 2A was removed using ProTaper Universal Retreatment (PTUR) instruments. This file series consist of 3 instruments (D1, D2 &D3) of different size and tapers. D1 file (size 30, .09 taper) for the cervical third, D2 file (size 25, .08 taper) for the middle third, and D3 file (size 20,.07 taper) for the apical third. The instruments were used with a speed 300 rpm and torque of 2 Ncm^{-1}.The file series have a convex cross section; D1 has a working tip that allows its initial penetration into filling materials[85].

The canal filling in group 1B and group 2B was removed using Mtwo retreatment files. This file system consists of two instruments of different sizes and tapers. File 1 have 15 tip size and .05 taper, maximum torque is 30 gcm (3 Ncm) and file 2 have 25 tip size and .05 taper, maximum torque is 120 gcm (1.2Ncm) and speed is 300 rpm/min. The Mtwo instruments have S-shaped cross section, an increasing pitch length in the apical-coronal direction. Therefore, these instruments are characterized by a positive rake angle with two cutting edges, which are claimed to cut dentin effectively[86].

The canal filling in Group 1C and group 2C was removed using D-RaCe retreatment instruments. D-RaCe rotary system consists of 2 instruments of different sizes and tapers.DR1 (size 30, .10 taper) at a speed of (1000 rpm and torque of 1.5 N cm) for the cervical third and beginning of the middle third and DR2 (size25, .04 taper) at 600-rpm speed and a torque of 0.7 N cm^{-1} till the working length[87].The files were designed by a triangular cross-section and with alternating cutting edges; DR1 have the length of 15 mm and the length of the DR2 is 25 mm.

The results in this study shows that among three systems, Protaper was found to be the best system in removing the gutta-percha and sealer from the root canal space followed

by D-RaCe and Mtwo though there was no significant differences between the three retreatment files. This is in accordance to the latest studies conducted by Patil A.et al 2018and Khedmat et al. in 2016 which showed greater efficacy of Protaper retreatment file series. According to their view the efficiency was due to the difference in the design of the file systems, which enables it to cut the superficial dentin along with the cutting of filling material. The progressive taper of D1, D2 and D3 files which enables the file to shape the specific areas of the canal wall with one file and the variable diameter, which provides defined cutting in specific sections without the instrument being stressed as there is no contact with other portions of the root canal wall and improves safety by decreasing the torsional load.

This files have a contionusly changing helical angle and a pitch over their 14 mm of cutting blades.Blancing the pitch and helical angle optimizes its cutting actions and it allows the blades to agur debris out of the canal and mainly prevents the instruments from inadverently screwing into the canal and it has a modifying guiding tip it allows instrument better flow into the canal and enhances the ability to find its way through soft tissue an loose debris without damaging the roo canal walls. In MTWO the tip is non cutting and variable helical angle reduces the tendency of the instrument to be suked into canal. In Race system it was thinner and has an inactive tip to make it difficult to penetrate the canal system[88,89,90,91,92,93,94].

In the future studies should be designed in an invivo situation to validate the results attained in this study and proving the efficacy of these retreatment file systems. Further studies should be preferred with various retreatment file systems, different obturation techniques and latest other retreatment evaluation methods.

SUMMARY

This in vitro study was done to evaluate the effectiveness of three different gutta-percha removing techniques in lateral and vertical compacted obturation technique using cone Beam computed Tomography (CBCT).

Ninety (90) single rooted freshly extracted mandibular premolars were selected for this study. All samples were analysed with digital radiograph (Satelec, Acteon, France) in buccal and proximal directions for confirming the existence of single straight canal, fully formed apex, no signs of internal resorption, calcification or previous endodontic therapy, caries and restoration or presence of dentin pins.

The samples were decoronated by using a diamond disc to attain a 15mm of standard root length and a reference point. After this, a conventional access cavity was prepared using Endo access bur. The working length was confirmed at 0.5 mm short of the estimated measurement. Then the samples were randomly allocated into two main groups of 45 samples in each. The root canals were obturated using lateral compaction method and warm vertical compaction method.

After obturation a primary CBCT was taken to assess the total volume of obturation material in both groups. Then root canals were sealed with temporary filling and the teeth stored at 37˚c in 100% humidity for two weeks. The primary CBCT analysis of all the prepared samples were randomly sub divided into six groups with 15 samples in each according to the retreatment technique.

After retreatment the prevalence of the residual filling material in each group was evaluated by estimating in the root canal space by obtaining post op CBCT. The volume of residual filling materialinside the canal was calculated .

The Data was collected and subjected to statistical analysis and were analysed using Statistical Package for Social Sciences (SPSS) Software version 21(IBM Statistics). Descriptive statistics include mean and standard deviation (SD) for all the samples tested and were analysed using ANOVA and LSD post hoc test.

The result of the study showed that Pro-Taper file retreatment system has been best in removing the obturation material compared to the D-Race and M-Two systems, irrespective of the obturation method adopted.

Within the limitations of the present study, it can be concluded that none of the retreatment systems completely removed filling material from the root canal space. Amongst three file system, Protaper was the most effective system in removing obturating material in lateral and warm vertical compaction groups . After retreatment lateral compaction group shows maximum volume of obturating material in root canal space when compared to lateral compaction group.

CONCLUSION

Within the limitations of the present study it can be concluded that

1. None of retreatment file systems tested (M-Two, D-Race, ProTaper) completely removed obturation materials regardless of the method of obturation.
2. Protaper retreatment system showed greater efficacy in removing obutrating material in lateral compaction and warm vertical compaction groups when compared to other two file systems (D-Race, M-Two).
3. After Retreatment the remaining obturation material was seen higher in lateral compaction group when compared to warm vertical compaction group regardless of retreatment file systems .

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This ethical committee has undergone the research protocol submitted by **Dr. Rinsa Raju,** Post Graduate Student, **Department of conservative dentistry and endodontics** under the title" **Efficacy of three different Rotary Retreatment systems to remove Laterally and Vertically compacted guttapercha - A Cone beam Computed tomographic evaluation"** under the guidance of **Dr.Rajesh Gopal V** for consideration of approval to proceed with the study.

This committee has discussed about the material being involved with the study, the qualification of the investigator, the present norms and recommendation from the Clinical Research scientific body and comes to a conclusion that this research protocol fulfills the specific requirements and the committee authorizes the proposal.

Dr. ANISHA CYNTHIA SATHIASEKAR MDS
CHAIR PERSON
Ethical Committee

RAJAS DENTAL COLLEGE & HOSPITAL
ETHICAL COMMITTEE & REVIEW BOARD

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CERTIFICATE -II

This is to certify that this dissertation work titled " **Efficacy of three different Rotary Retreatment systems to remove Laterally and Vertically compacted guttapercha - A Cone beam Computed tomographic evaluation** " of the candidate **Dr.Rinsa Raju** with registration number **241617202** for the award of **Master of Dental Surgery** in the branch of **Conservative Dentistry and Endodontics -Branch - IV** . I personally verified the urukund.com website for the purpose of plagiarism check .I found that the uploaded thesis file contains from introduction and conclusion pages and result shows **5** percentage of plagiarism in the dissertation.

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